

WHAT IS CLAIMED IS:

- 1        1.        A method, comprising:
  - 2            monitoring paths between a first controller and second controller;
  - 3            determining whether one path has been unavailable for a predetermined time
  - 4            period in response to detecting that the path is unavailable;
  - 5            indicating the path in a first failed state if the path has been unavailable for more
  - 6            than the predetermined time period; and
  - 7            indicating the path in a second failed state if the path has not been unavailable for
  - 8            the predetermined time period.
  
- 1        2.        The method of claim 1, further comprising:
  - 2            indicating the path in a functioning state if the path is determined to be available.
  
- 1        3.        The method of claim 1, wherein the first failed state comprises a
- 2        permanent failed state and the second failed state comprises a transient failed state.
  
- 1        4.        The method of claim 1, further comprising:
  - 2            receiving a write request;
  - 3            returning fail to the write request in response to determining that all paths are in
  - 4            the first failed state; and
  - 5            queuing the write request in a queue in response to determining that at least one
  - 6            path is in the second failed state and no paths are indicated in a functioning state.
  
- 1        5.        The method of claim 4, further comprising:
  - 2            submitting the write request to one path indicated in the functioning state to
  - 3            transmit to the secondary controller in response to determining that at least one path is in
  - 4            the functioning state.
  
- 1        6.        The method of claim 4, wherein at least one primary volume managed by
- 2        the primary controller and at least one secondary volume managed by the secondary

3 controller are designated as volume pairs, wherein writes to one primary volume in one  
4 volume pair is copied to the corresponding secondary volume in the volume pair, further  
5 comprising:

6 suspending one volume pair including the primary volume to which the write  
7 request is directed in response to determining that all paths are in the first failed state.

1 7. The method of claim 4, further comprising:  
2 periodically processing the queue and write requests queued therein; and  
3 submitting the write requests in the queue to one path indicated in the functioning  
4 state to transmit to the secondary controller in response to determining that at least one  
5 path is in the functioning state

1 8. The method of claim 4, further comprising:  
2 indicating a time the write request was received when queuing the write request in  
3 the queue; and  
4 returning fail to one write request in the queue in response to determining that the  
5 write request has been queued longer than a request timeout period.

1 9. The method of claim 8, further comprising:  
2 periodically processing the queue and write requests queued therein to determine  
3 whether to return fail to those write requests queued longer than the request timeout  
4 period.

1 10. The method of claim 9, further comprising:  
2 determining whether at least one path is in a functioning state when periodically  
3 processing the queue, wherein fail is only returned to those write requests having been  
4 queued longer than the request timeout period in response to determining that no path is  
5 in the functioning state.

1        11.     The method of claim 1, further comprising:  
2            receiving a read request to access requested data;  
3            returning the requested data with the first controller in response to determining  
4        that the data is available at a first storage coupled to the first controller;  
5            determining that the requested data is not available at the first storage;  
6            returning fail to the read request in response to determining that all paths are in  
7        the first failed state in response to determining that the data is not available at the first  
8        storage; and  
9            queuing the read request in a queue to transfer to the secondary controller to  
10      access the requested data from a second storage in response to determining that at least  
11      one path is in the second failed state and no paths are indicated in a functioning state in  
12      response to determining that the data is not available at the first storage.

1        12.     The method of claim 1, further comprising:  
2            performing a failover to the second controller to service I/O requests through the  
3        second controller in response to detecting a failure related to the first controller;  
4            logging updates made by the second controller during the failover;  
5            transferring logged updates from the second controller to the primary controller in  
6        response to a fallback to the first controller;  
7            returning fail to the transfer of one logged update to the first controller in response  
8        to determining that all paths are in the first failed state; and  
9            queuing one logged update to transfer to the first controller in a queue in response  
10      to determining that at least one path is in the second failed state and no paths are  
11      indicated in a functioning state.

1        13.     A system, comprising:  
2            a first controller;  
3            a second controller;  
4            paths between the first and second controller;  
5            code executed by the first controller to perform:

6 (i) monitoring paths between a first controller and second controller;

7 (ii) determining whether one path has been unavailable for a

8 predetermined time period in response to detecting that the path is unavailable;

9 (iii) indicating the path in a first failed state if the path has been

10 unavailable for more than the predetermined time period; and

11 (iv) indicating the path in a second failed state if the path has not been

12 unavailable for the predetermined time period.

1        14. The system of claim 13, wherein the code is executed by the first  
2 controller to further perform:  
3            indicating the path in a functioning state if the path is determined to be available.

1        15. The system of claim 13, wherein the first failed state comprises a  
2 permanent failed state and the second failed state comprises a transient failed state.

- 1        16. The system of claim 13, wherein the code is executed by the first
- 2 controller to further perform:
  - 3        receiving a write request;
  - 4        returning fail to the write request in response to determining that all paths are in
  - 5 the first failed state; and
  - 6        queuing the write request in a queue in response to determining that at least one
  - 7 path is in the second failed state and no paths are indicated in a functioning state.

1           17. The system of claim 16, wherein the code is executed by the first  
2 controller to further perform:  
3           submitting the write request to one path indicated in the functioning state to  
4 transmit to the secondary controller in response to determining that at least one path is in  
5 the functioning state.

1        18.    The system of claim 16, wherein at least one primary volume managed by  
2    the primary controller and at least one secondary volume managed by the secondary  
3    controller are designated as volume pairs, wherein writes to one primary volume in one  
4    volume pair is copied to the corresponding secondary volume in the volume pair, and  
5    wherein the code is executed by the first controller to further perform:

6                suspending one volume pair including the primary volume to which the write  
7    request is directed in response to determining that all paths are in the first failed state.

1        19.    The system of claim 16, wherein the code is executed by the first  
2    controller to further perform:

3                periodically processing the queue and write requests queued therein; and  
4                submitting the write requests in the queue to one path indicated in the functioning  
5    state to transmit to the secondary controller in response to determining that at least one  
6    path is in the functioning state

1        20.    The system of claim 16, wherein the code is executed by the first  
2    controller to further perform:

3                indicating a time the write request was received when queuing the write request in  
4    the queue; and

5                returning fail to one write request in the queue in response to determining that the  
6    write request has been queued longer than a request timeout period.

1        21.    The system of claim 20, wherein the code is executed by the first  
2    controller to further perform:

3                periodically processing the queue and write requests queued therein to determine  
4    whether to return fail to those write requests queued longer than the request timeout  
5    period.

1        22.    The system of claim 21, wherein the code is executed by the first  
2    controller to further perform:

3        determining whether at least one path is in a functioning state when periodically  
4    processing the queue, wherein fail is only returned to those write requests having been  
5    queued longer than the request timeout period in response to determining that no path is  
6    in the functioning state.

1        23.    The system of claim 13, wherein the code is executed by the first  
2    controller to further perform:

3            receiving a read request to access requested data;  
4            returning the requested data with the first controller in response to determining  
5    that the data is available at a first storage coupled to the first controller;  
6            determining that the requested data is not available at the first storage;  
7            returning fail to the read request in response to determining that all paths are in  
8    the first failed state in response to determining that the data is not available at the first  
9    storage; and

10          queuing the read request in a queue to transfer to the secondary controller to  
11    access the requested data from a second storage in response to determining that at least  
12    one path is in the second failed state and no paths are indicated in a functioning state in  
13    response to determining that the data is not available at the first storage.

1        24.    The system of claim 13, further comprising:  
2    code executed by the second controller to perform:

3            (i) performing a failover from the first controller to the second controller  
4    to service I/O requests through the second controller in response to detecting a  
5    failure related to the first controller;  
6            (ii) logging updates during the failover;  
7            (iii) transferring logged updates to the primary controller in response to a  
8    fallback to the first controller;  
9            (iv) returning fail to the transfer of one logged update to the first controller  
10    in response to determining that all paths are in the first failed state; and

11 (v) queuing one logged update to transfer to the first controller in a queue  
12 in response to determining that at least one path is in the second failed state and  
13 no paths are indicated in a functioning state.

1           25. An article of manufacture for monitoring paths between a first controller  
2 and second controller, wherein the article of manufacture is capable of causing operations  
3 to be performed, the operations comprising:

4 determining whether one path has been unavailable for a predetermined time  
5 period in response to detecting that the path is unavailable;

6 indicating the path in a first failed state if the path has been unavailable for more  
7 than the predetermined time period; and

8 indicating the path in a second failed state if the path has not been unavailable for  
9 the predetermined time period.

1                   26. The article of manufacture of claim 25, wherein the operations further  
2 comprise:

3 indicating the path in a functioning state if the path is determined to be available.

1           27. The article of manufacture of claim 25, wherein the first failed state  
2 comprises a permanent failed state and the second failed state comprises a transient failed  
3 state.

1           28. The article of manufacture of claim 25, wherein the operations further  
2 comprise:

3 receiving a write request;

4 returning fail to the write request in response to determining that all paths are in  
5 the first failed state; and

6 queuing the write request in a queue in response to determining that at least one  
7 path is in the second failed state and no paths are indicated in a functioning state.

1        29.    The article of manufacture of claim 28, wherein the operations further  
2    comprise:

3            submitting the write request to one path indicated in the functioning state to  
4    transmit to the secondary controller in response to determining that at least one path is in  
5    the functioning state.

1        30.    The article of manufacture of claim 28, wherein at least one primary  
2    volume managed by the primary controller and at least one secondary volume managed  
3    by the secondary controller are designated as volume pairs, wherein writes to one primary  
4    volume in one volume pair is copied to the corresponding secondary volume in the  
5    volume pair, wherein the operations further comprise:

6            suspending one volume pair including the primary volume to which the write  
7    request is directed in response to determining that all paths are in the first failed state.

1        31.    The article of manufacture of claim 28, wherein the operations further  
2    comprise:

3            periodically processing the queue and write requests queued therein; and  
4            submitting the write requests in the queue to one path indicated in the functioning  
5    state to transmit to the secondary controller in response to determining that at least one  
6    path is in the functioning state

1        32.    The article of manufacture of claim 28, wherein the operations further  
2    comprise:

3            indicating a time the write request was received when queuing the write request in  
4    the queue; and

5            returning fail to one write request in the queue in response to determining that the  
6    write request has been queued longer than a request timeout period.

1        33.    The article of manufacture of claim 32, wherein the operations further  
2    comprise:

3       periodically processing the queue and write requests queued therein to determine  
4    whether to return fail to those write requests queued longer than the request timeout  
5    period.

1       34.    The article of manufacture of claim 33, wherein the operations further  
2    comprise:

3       determining whether at least one path is in a functioning state when periodically  
4    processing the queue, wherein fail is only returned to those write requests having been  
5    queued longer than the request timeout period in response to determining that no path is  
6    in the functioning state.

1       35.    The article of manufacture of claim 25, wherein the operations further  
2    comprise:

3       receiving a read request to access requested data;  
4       returning the requested data with the first controller in response to determining  
5    that the data is available at a first storage coupled to the first controller;  
6       determining that the requested data is not available at the first storage;  
7       returning fail to the read request in response to determining that all paths are in  
8    the first failed state in response to determining that the data is not available at the first  
9    storage; and

10      queuing the read request in a queue to transfer to the secondary controller to  
11    access the requested data from a second storage in response to determining that at least  
12    one path is in the second failed state and no paths are indicated in a functioning state in  
13    response to determining that the data is not available at the first storage.

1       36.    The article of manufacture of claim 25, wherein the operations further  
2    comprise:

3       performing a failover to the second controller to service I/O requests through the  
4    second controller in response to detecting a failure related to the first controller;

5           logging updates made by the second controller during the failover;

6           transferring logged updates from the second controller to the primary controller in

7           response to a failback to the first controller;

8           returning fail to the transfer of one logged update to the first controller in response

9           to determining that all paths are in the first failed state; and

10          queuing one logged update to transfer to the first controller in a queue in response

11          to determining that at least one path is in the second failed state and no paths are

12          indicated in a functioning state.